



Vector Radiative Transfer in CAO systems and applications

Pengwang Zhai¹, Yongxiang Hu¹,
Chris A. Hostetler¹, Brian Cairns², Richard A. Ferrare¹, J. Chowdhary
Kirk Knobelspiesse¹, Damien B. Josset¹, Charles R. Trepte¹, Patricia L. Lucker¹

¹ NASA LaRC

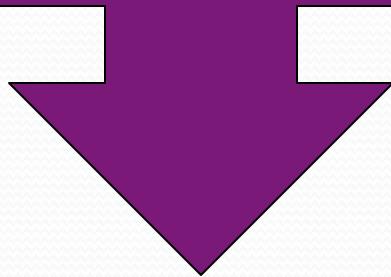
² NASA GISS

Motivation

Polarimeter is indispensable for satellite missions (PARASOL, GLORY, ACE, GEOCAPE, etc.)

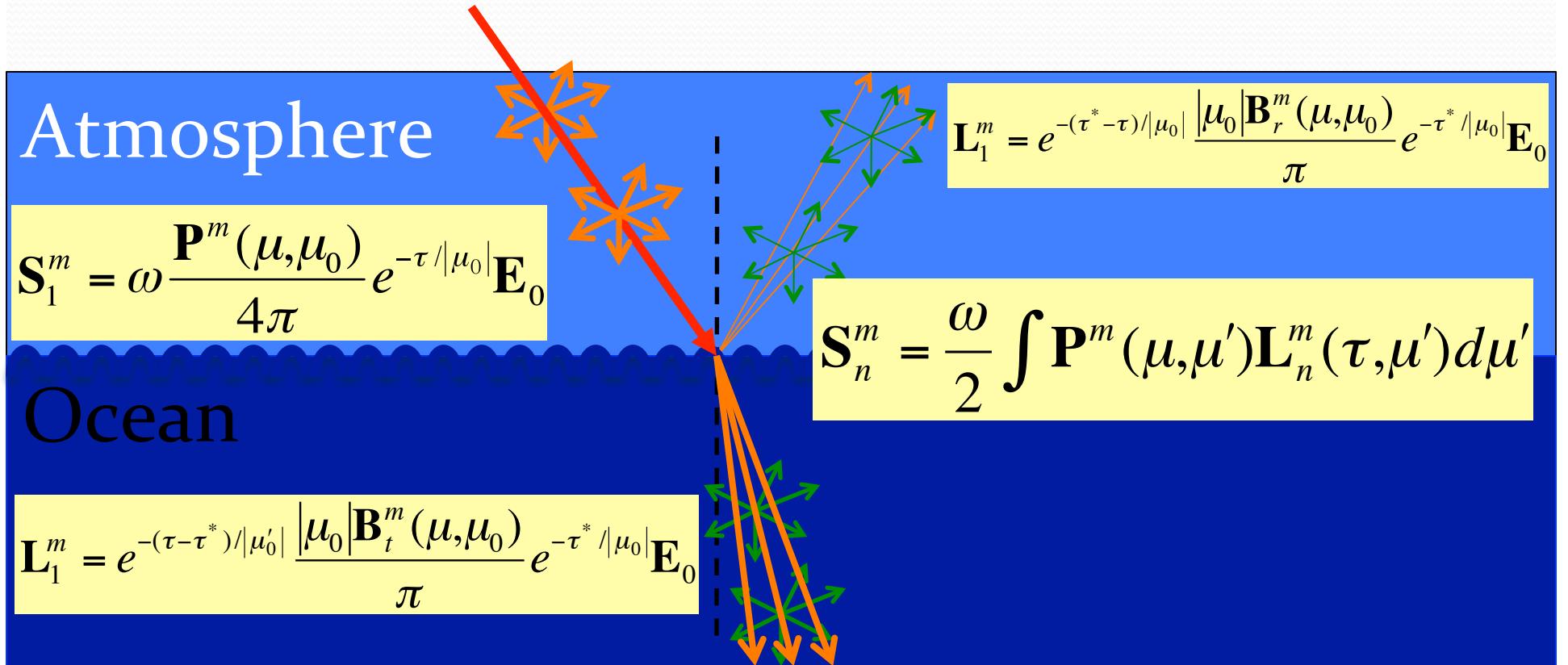
A combination of active and passive remote sensing will serve a unique role for ACE-like missions.

The interpretation of many field measurements needs to simulate polarized light multiply scattered in atmosphere and ocean.



A fast vector radiative transfer package with flexibility and accuracy.

Vector Radiative Transfer (VRT) Model



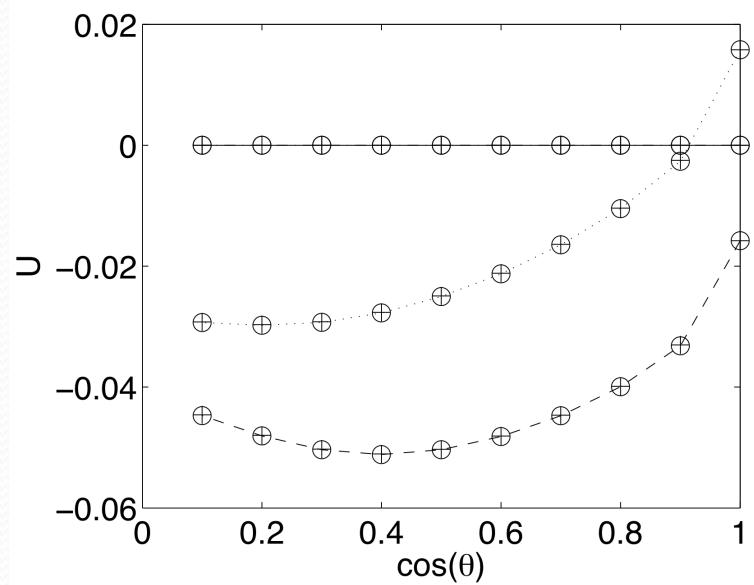
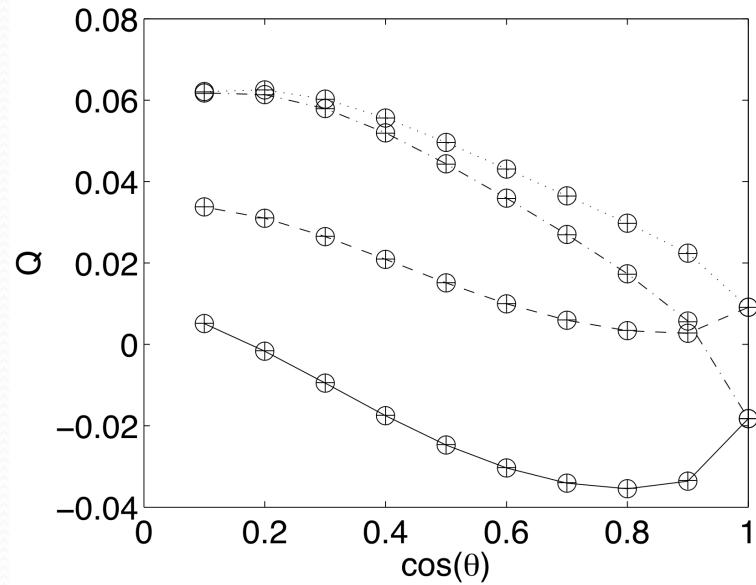
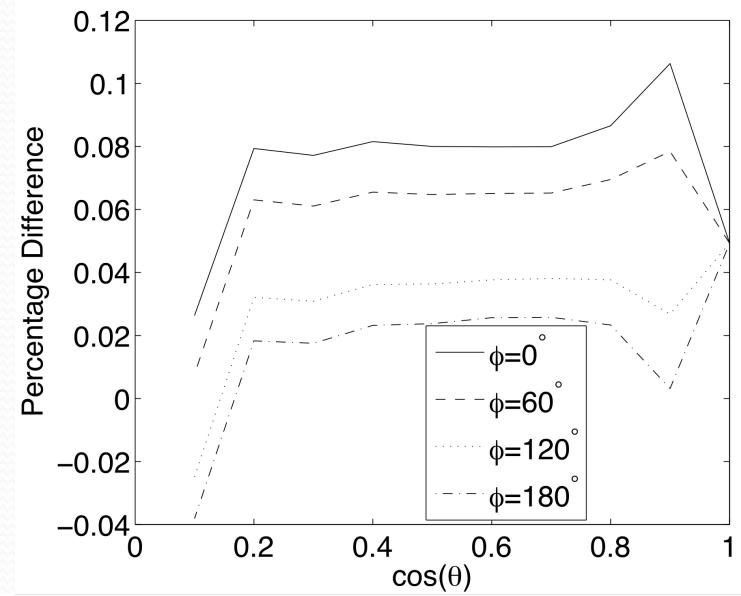
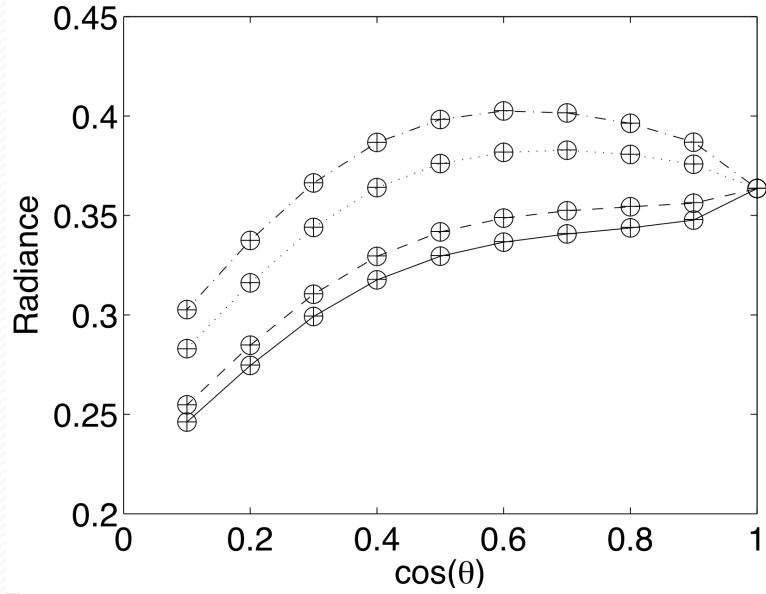
$$\mathbf{L}_n^m(\tau, \mu > 0) = \int_{\tau}^{\tau^*} \exp\{-(\tau' - \tau)/\mu\} \mathbf{S}_n^m(\tau', \mu) d\tau' / \mu$$

$$\mathbf{L}_n^m(\tau, \mu < 0) = \int_0^{\tau} \exp\{-(\tau' - \tau)/\mu\} \mathbf{S}_n^m(\tau', \mu) d\tau' / |\mu|$$

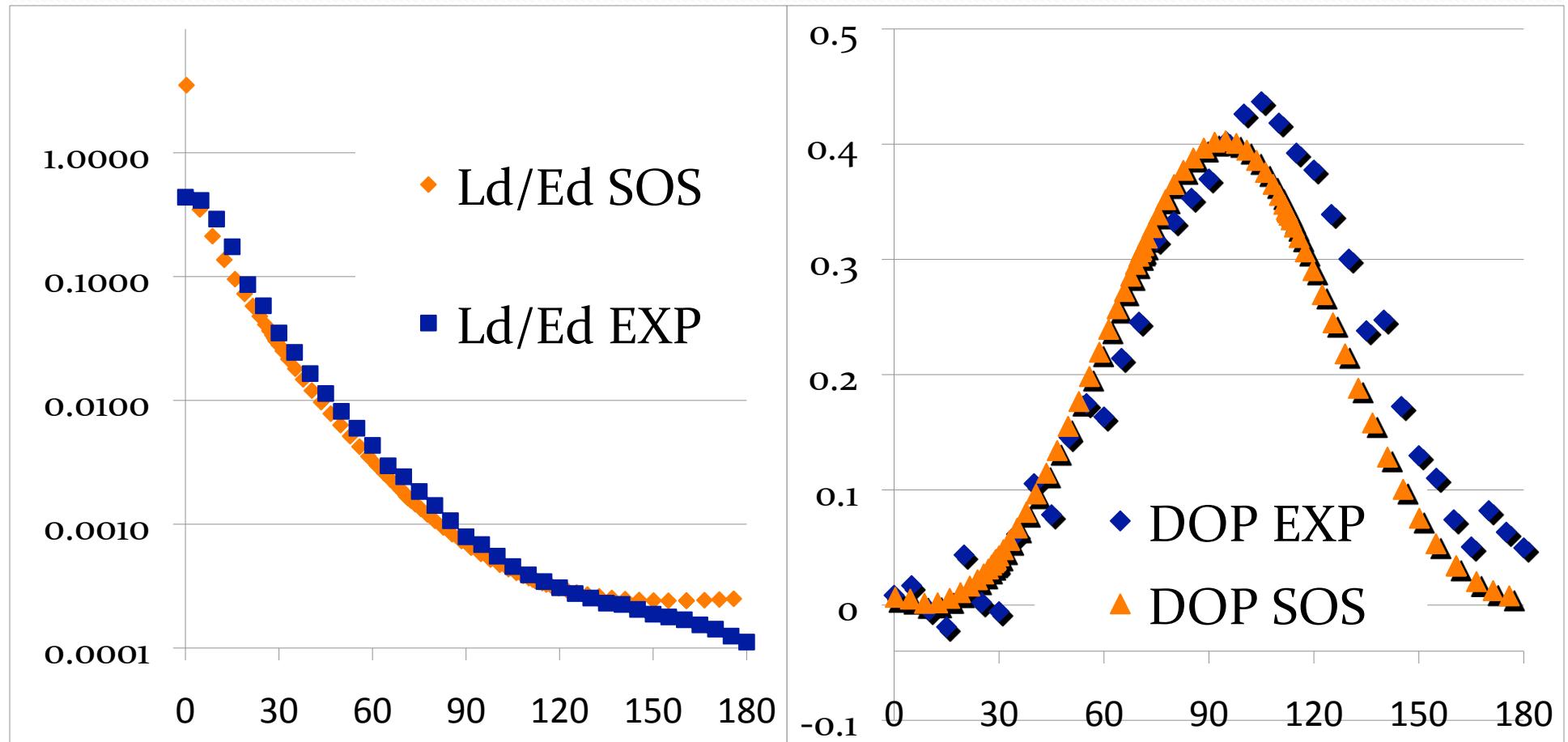
Zhai, P, Y. Hu, J. Chowdhary, C. R. Trepte, P. L. Lucker, D. B. Josset, "A vector radiative transfer model for coupled atmosphere and ocean systems with a rough interface," *J Quant Spectrosc Radiat Transf*, **111**, 1025-1040 (2010).

Zhai, P, Y. Hu, C. R. Trepte, and P. L. Lucker, "A vector radiative transfer model for coupled atmosphere and ocean systems based on successive order of scattering method," *Opt. Express* **17**, 2057-2079 (2009).

Model Comparison

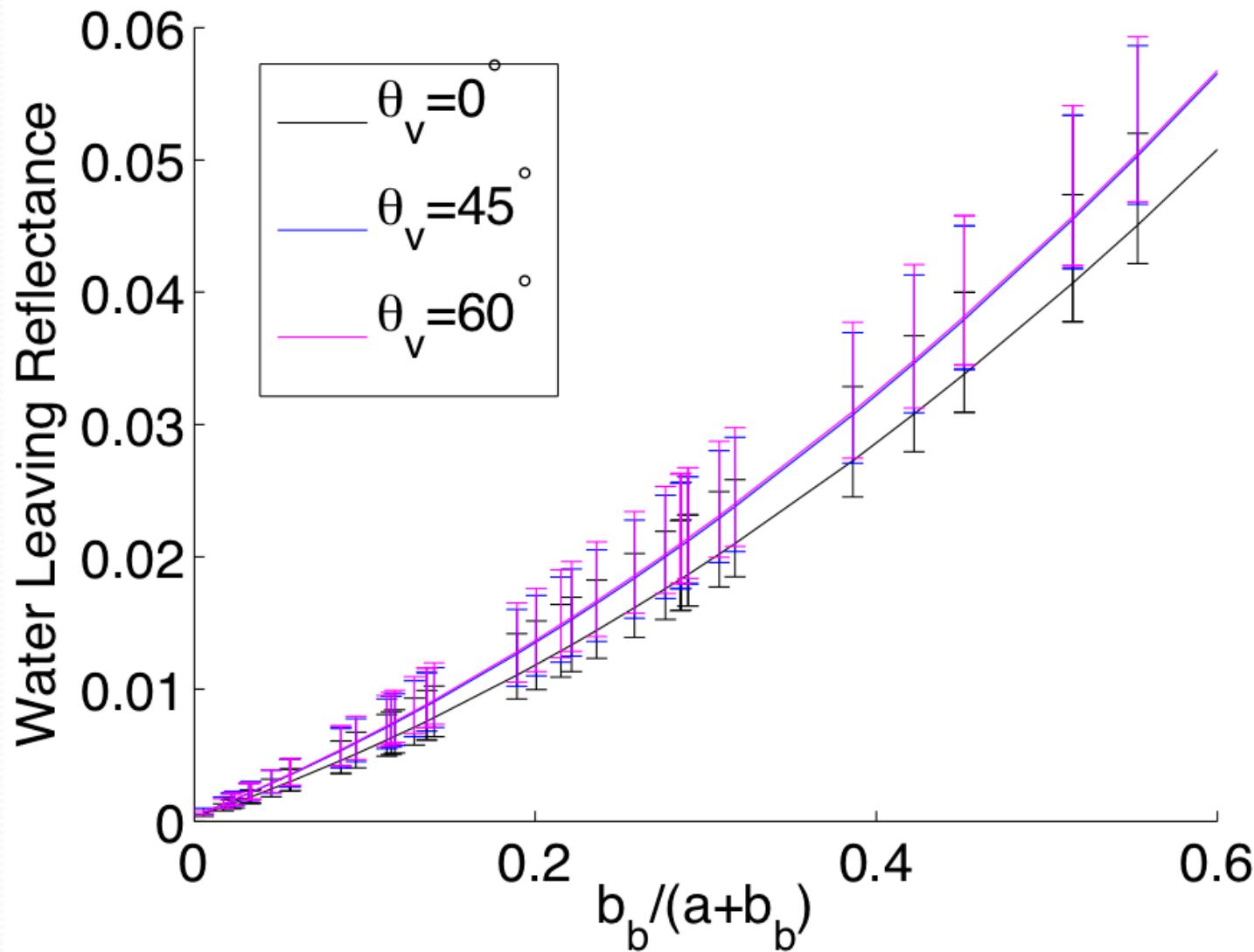


Model vs Field observation

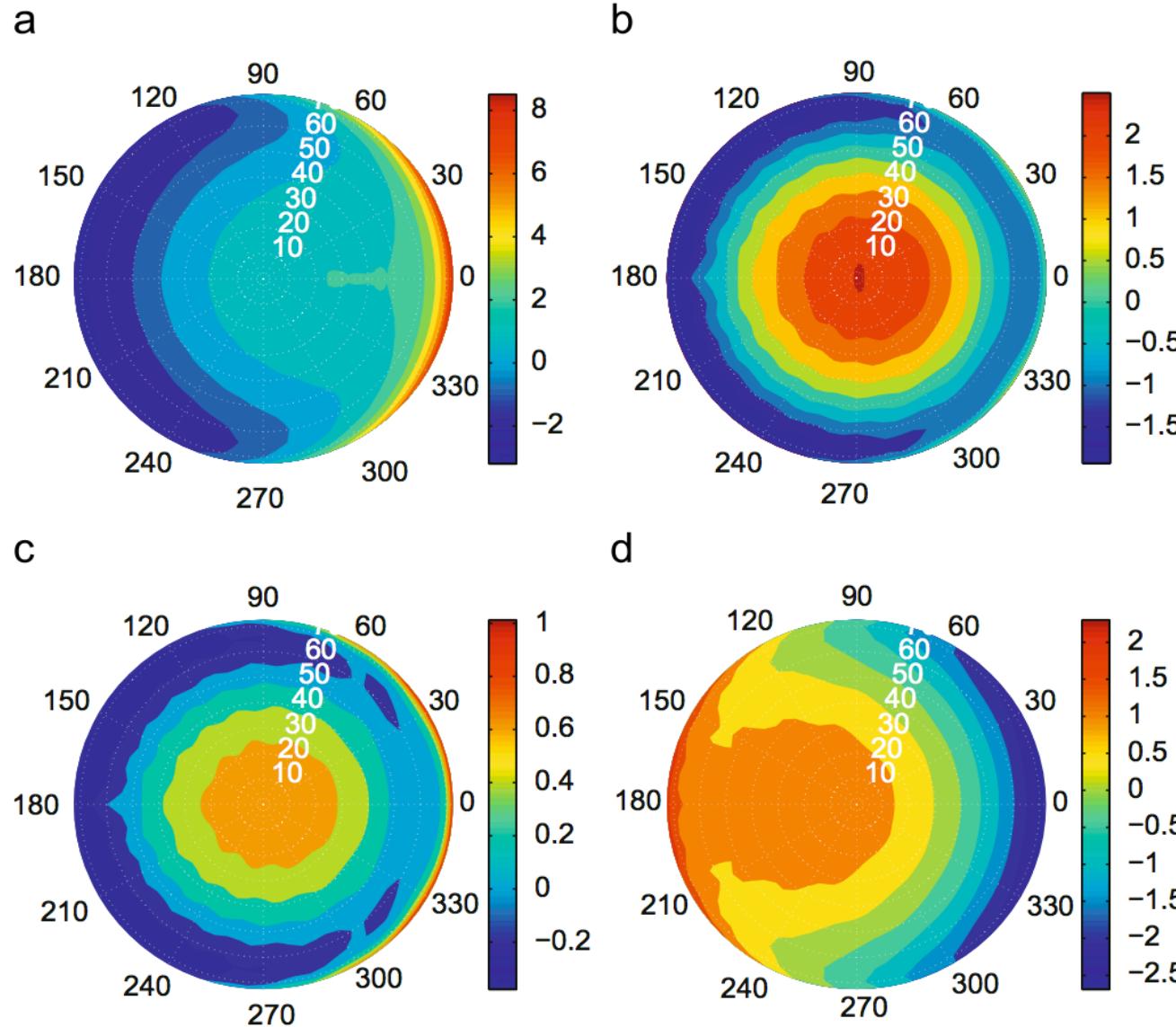


Experimental Data Provided by *Optical Remote Sensing Laboratory, CCNY*

Ocean Color Study: Viewing Angle

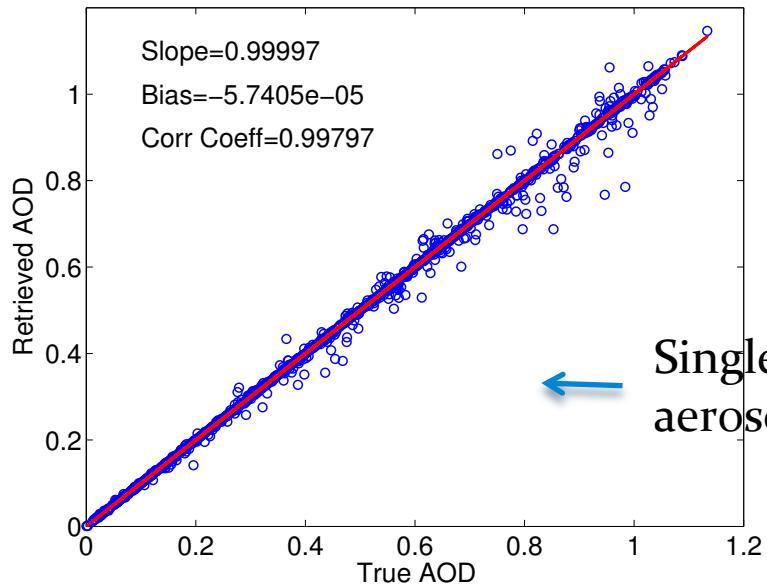


Ocean Color Study: Decoupling Error

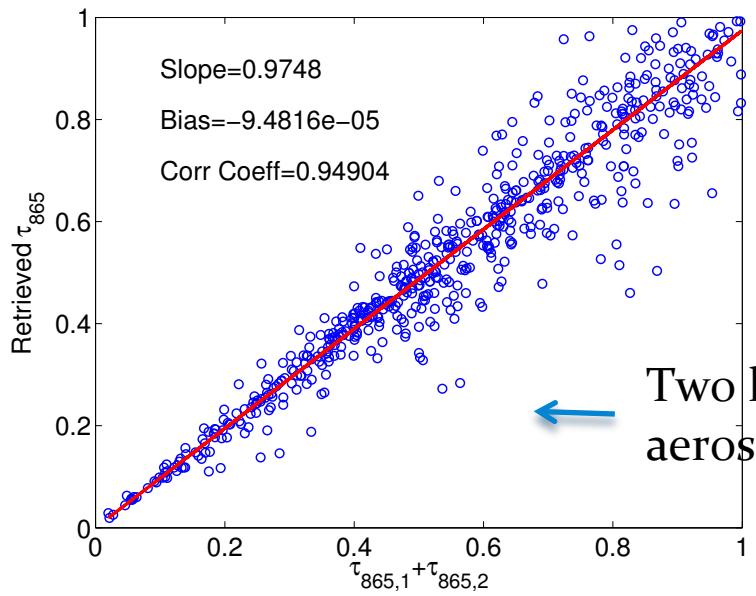
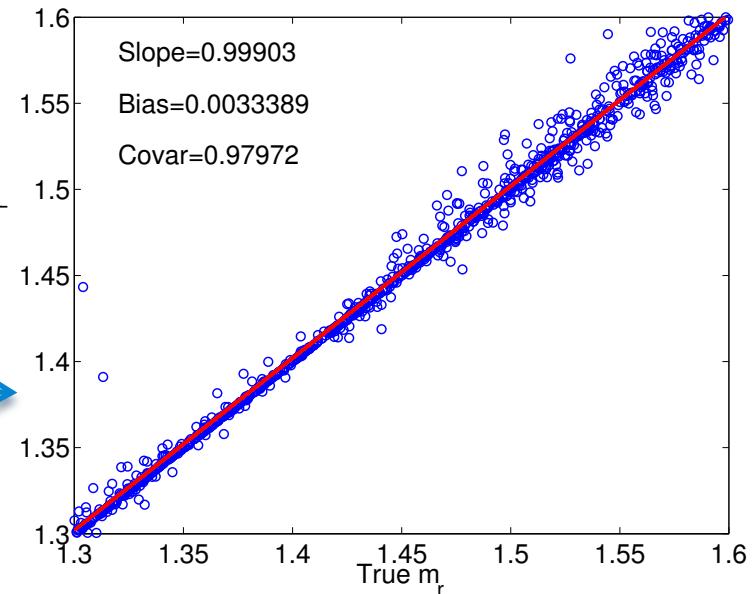


The decoupling radiance error at the TOA. $\theta_s=60^\circ$ (a)
chlorophyll a concentration [Chl] = 0.3 mg m^{-3} the wavelength 412 nm.
(b) chlorophyll a concentration [Chl] = 3 mg m^{-3} wavelength 412 nm. (c)
chlorophyll a concentration [Chl] = 0.3 mg m^{-3} and wavelength 555 nm.
(d) chlorophyll a concentration [Chl]= 3 mg m^{-3} and wavelength 555 nm.

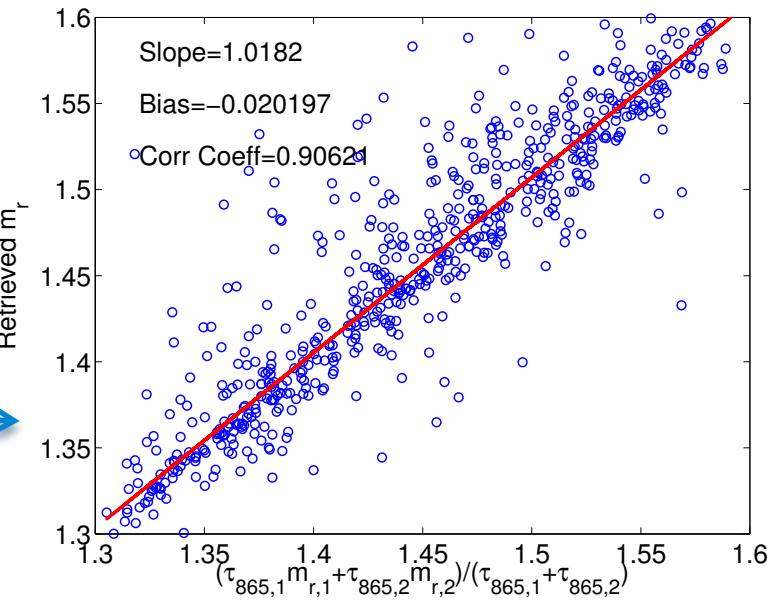
Aerosol Application: Multilayer Aerosol Sensitivity



Single layer
aerosol test



Two layer
aerosol test



Conclusion

- A vector radiative transfer model has been built for coupled atmosphere and ocean system based on the successive order of scattering method.
- The code is accurate, efficient and easy to use. A few examples of the usage of the SOS code are:
 - Aerosol retrieval algorithm using Least squares fitting of the RSP instrument data.
 - Ocean water leaving simulation to study the ocean water back scatter and viewing angle sensitivity.
 - Ocean color decoupling error study.